DRAFT MODIFIED QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR SUPPORT OF A VAPOR INTRUSION STUDY

AT THE

FORMER ARMY MATERIALS TECHNOLOGY LABORATORY, WATERTOWN, MA

SEPTEMBER 30, 2016

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List of Acronyms

AMTL	Army Materials Technology Laboratory
Ca	Carcinogenic risk
CAS	Chemical Abstract Service
DOD	Department of Defense
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EDQW	The DOD Environmental Data Quality Workgroup
GC/MS	Gas Chromatograph/Mass Spectrometer
LCS	Laboratory Control Sample
LOQ	Limit of Quantitation
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
nc	Noncancer Health Effect
µg/L	micrograms/liter
$\mu g/m^3$	micrograms per cubic meter
MPC	Measurement Performance Criteria
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PCE	Tetrachloroethene
QAPP	Quality Assurance Project Plan
QA	Quality Assurance
QC	Quality Control
RBC	Risk Based Concentration
RI	Remedial Investigation

RL	Reporting Limit
RPD	Relative Percent Difference
RSL	Regional Screening Level
SEDD	Staged Electronic Data Deliverable
SOP	Standard Operating Procedure
TCE	Trichloroethene
TIC	Tentatively Identified Compound
UFP	Unified Federal Programs
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 Project Description

The Army Materials Technology Laboratory (AMTL) in Watertown, Massachusetts is a Superfund Site for which there are three Records of Decision (ROD). Four five year reviews have been completed for AMTL since the remedies were initiated. The 1996 ROD for OU1 soils and groundwater stated that no risk assessment was performed for groundwater because there are no known exposures. According to the ROD, although some contamination is present in certain areas of onsite groundwater, there is no current risk posed because the groundwater is not used as a water supply and therefore there are no receptors, and no significant migration of contamination is occurring in offsite groundwater. The RI/FS determined that groundwater at that time met the state MassDEP definition of GW-3 for a non-drinking water aquifer, and found that there was no risk identified for human receptors because there is no direct contact with groundwater. However, potential risk for human exposure to contaminants in groundwater via vapor intrusion was not addressed at that time. The absence of an assessment of a vapor intrusion pathway (VIP) at the site was listed as an issue in the fourth five-year review (FYR) report dated March 2016. The presence of vapor-forming chemicals and potential receptors indicate the possibility of a complete vapor intrusion pathway. The issue of a lack of VIP assessment calls into question the protectiveness of the remedy which is documented in the FYR report. For this reason the protectiveness of the remedy for OU1 is deferred until a VIP study is completed.

1.1 Purpose of Modified QAPP

This Quality Assurance Project Plan (QAPP) describes the approach that the United States Army Corps of Engineers, New England District (USACE-NAE) will use to validate groundwater data already collected to support a screening level assessment of a possible VIP. The validated groundwater data will be entered in the USEPA Vapor Intrusion Screening Level (VISL) Calculator to determine if any volatile organic compound (VOC) in groundwater could migrate into the indoor air at a concentration which produces a potential risk greater than 1.0×10^{-06} for cancer or a hazard Quotient (HQ) of 1 for a noncancer health effect. A groundwater contaminant iso-contour map will also be developed by a USACE-NAE hydrogeologist, to determine if the indoor air of any buildings could be impacted by the underlying groundwater based on the proximity of groundwater at VOC concentrations of potential concern near occupied buildings. This component makes up part of a more comprehensive VI study which will be performed by a contractor to USACE-NAE in early 2017. The contractor will be responsible for identifying any data gaps for the VIP evaluation and preparing a work plan to address these data gaps which likely will include indoor air and sub-slab soil gas sampling and additional groundwater sampling. As part of this effort the contractor will develop a complete QAPP following the UFP (Uniform Federal Policy) format. Therefore, this modified UFP-QAPP will only provide the information necessary to validate existing groundwater data in order to determine if it could contribute to a complete VIP. Usually a QAPP is utilized as a planning document for obtaining data to

meet a projects data quality objectives for data acquisition. In this case the QAPP is being utilized for review of existing 2nd party data. The analytical data were collected under the Massachusetts Contingency Plan (MCP) by Athena health (building owners) and their contractors Haley & Aldrich and Sanborn, Head & Associates, Inc.

1.2 Measurement Performance Criteria

The criteria in this QAPP are to determine if the data collected under the MCP meets requirements under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) by evaluating the data using USEPA and USACE guidance for data assessment. The information in this modified QAPP will be used to create an electronic QAPP (eQAPP). Once permission is given for USACE to obtain the existing groundwater data, collected by Athena health, from Alpha Analytical Laboratories the data will be requested from the lab in SEDD (Staged Electronic Data Deliverable) format 5.2 and stage 2a or above. Stage 2a includes:

- Information and data to check the completeness and compliance of sample condition upon laboratory receipt,
- The analytical test results for requested samples, and
- Sample-related QC results (e.g., laboratory control sample performance associated with field samples).

The SEDD format is an *.xml file which can be run through the USACE's automated data review software, ADR.net, against the eQAPP. The results of the data validation will be documented in a data validation report. Alpha Analytical currently does not have DOD ELAP (environmental laboratory accreditation program) accreditation and therefore the data will be evaluated for accuracy and precision against the laboratory control sample criteria in the DOD Quality Systems Manual (QSM) for Environmental Laboratories Version 5.0. The sensitivity requirement is based on whether the laboratory quantitation limits are low enough to show no unacceptable risk to receptors breathing indoor air as impacted by underlying groundwater.

1.2.1 Sensitivity

The project action levels (PAL) for groundwater relative to indoor air were calculated as follows.

The USEPA Industrial indoor air regional screening levels (RSLs) were evaluated to determine the lower of the RSLs i.e. the RSL for caner or noncancer health effect (USEPA, 2016b) If an RSL was only listed for one health effect, that RSL was used. In the cases where no indoor air RSL was available the residential tap water RSL was utilized instead and this is footnoted in Table 1 (USEPA, 2016c). If no RSL existed for the VOC this is also noted in the Table 1.

For all compounds except 1,2,3-trichloropropane the health effect for the indoor air RSL is the same as the tap water RSL. The RSL for tap water for dermal contact, ingestion and inhalation (showering model only) is based on cancer risk and the lower indoor air RSL is for a noncancer health effect. Tap water RSLs are based on the assumption that the water is consumed at a residential tap water consumption rate. Indoor air RSLs are for a commercial exposure scenario. The USEPA RSLs are shown for a 1×10^{-06} cancer risk level and a noncancer hazard quotient (HQ) of 0.1. Per CERCLA guidance the RSLs based on non-cancer effects should correspond to an HQ of 0.1 for sites where multiple contaminants may be present. The noncancer RSLs in Tables 1 and 2 correspond to an HQ of 0.1.

The lower of the industrial indoor air RSLs was entered into the USEPA Vapor Intrusion Screening Level (VISL) calculator in the GW_IA tab as the Calculated Indoor Air Concentration (Cia µg/m^3). The goal seek function was utilized to determine the groundwater concentration which yields the entered indoor air concentration or RSL. This groundwater concentration is listed in the project action level (PAL) column. Refer to Table 2 for the VISL showing groundwater PALs corresponding to their respective RSL.

The project quantitation goal limit for groundwater (in µg/L) was determined to be five times lower than the PAL when this concentration was achievable by the given laboratory limits for USEPA SW-846 method 8260. Alpha Analytical refers to their method quantitation limit as the limit of quantitation, LOQ, which is the preferred DOD QSM terminology for a quantitation limit. Up until 2016 Alpha Analytical maintained DOD ELAP accreditation, however the lab did not renew their DOD ELAP accreditation this year and it has lapsed. In cases where the laboratory-specific quantitation level could not meet the desired PAL at five times below the PAL, a target LOQ concentration three times lower than the PAL was calculated. Ideally the LOQ for organic analyses is 3-5 times lower than the PAL (USACE, 2005). Compounds which do not meet this criteria are highlighted in yellow in Table 1 and are; chloroform, carbon tetrachloride, dibromochloromethane, 1,1,2-trichloroethane (1,1,2-TCA), 1,2-Dibromoethane, 1,2-Dibromo-3-chloropropane, hexachlorobutadiene and 1,2,3-trichlorobenzene. In all cases, except 1,2-Dibromo-3-chloropropane, the method detection limit (MDL) is lower

than the target LOQ, so a positive detection will show that the compound does exist in the sample (within 99% certainty). However, concentrations in this range (between the MDL and LOQ) will be qualified as estimates. The sample results will be qualified as necessary and the data usability determined accordingly. This will be documented in the data validation report.

1.2.2 Accuracy and Precision

The laboratory control sample (LCS) percent recoveries for each compound will be entered into the eQAPP as listed in Table 3 below. These LCS limits as listed in the current version of the DOD QSM were derived as follows. The DOD Environmental Data Quality Workgroup (EDQW) determined that both DOD and DOE would benefit from updating the existing Laboratory Control Sample (LCS) control limits that were established as a result of a study conducted in 1999 and reported in the 2004 LCS study. The initial study (reported in 2004) was based on a limited data set and did not include all the laboratories and methods that are now a part of DOD ELAP and DOECAP. The objective of the new study was to develop updated LCS limits and provide values for an expanded scope of methods. The new LCS study, conducted in the summer of 2012, incorporated the contributions from approximately 50 DOD ELAP and DOECAP accredited/approved laboratories. In all, 6.5 million records were analyzed, and LCS limits were set for 23 methods and approximately 1,280 matrix-method-analyte combinations. Based on the laboratory LCS sample data, control limits were calculated for all matrix-method-analyte combinations that met the criteria (a minimum of 100 records) for having sufficient data. Control limits were calculated as the sample mean ± 3 sample standard deviations (DOD/DOE, 2013). These limits will also be used for any matrix spike/matrix spike duplicate samples if collected.

2.0 Analytical Procedures

As indicated above the laboratory utilized for the groundwater analysis for the AMTL project is Alpha Analytical:

Alpha Analytical

8 Walkup Drive

Westborough, MA 01581

Nathalie Lewis

Assistant Project Manager

Email: nlewis@alphalab.com <mailto:nlewis@alphalab.com>

Direct: 508-439-5170

Main: 508-898-9220

Currently the lab is performing SW-846 method 8260C for VOC analysis in groundwater.

3.0 Electronic Data Deliverables (EDDs)

EDDs from Alpha will be requested in SEDD 5.2 format in Stage 2a or higher. These EDDs will be generated from the laboratory information system (LIMS) in order to meet CERCLA reporting requirements. The SEDD file can be run against the USACE eQAPP by utilizing Laboratory Data Consultants (LDC) automated data review (ADR) software, ADR.net, which was developed by LDC for the USACE.

SEDD is a hierarchal file created by a Laboratory Information Management System (database) and contains information regarding the chemical analysis of samples. Information (analytical results) from a SEDD file can be checked using automated data review tools. More information on SEDD format, specifically 5.2, is described at the website; https://www.epa.gov/clp/sedd-valid-values-sedd-specification-document-52

4.0 Data Assessment Procedures

The purpose of data quality assessment is to ensure that data generated for this project are accurate and consistent with project objectives. USACE-NAE will follow the data assessment procedures detailed in this modified QAPP and the corresponding project eQAPP. Definitive off-site laboratory data generated for VOCs will be validated using USACE guidelines in Engineering Manual Guidance for Evaluation Performance Based Chemical Data, EM-200-1-10 http://www.usace.army.mil/inet/usace-docs/ (USACE, 2005), USEPA National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2016d) and professional judgement. The data validation will include a modified Tier II/Stage 2a validation of all groundwater samples. The QC limits specified in Tables1 and 3 of this Modified QAPP will be used as project-specific QC goals. All assessments, qualifications, and professional judgments will be summarized in a data validation report along with the output files from ADR.net.

5.0 References

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USACE, 2016a. Remedial Action Work Plan for a Vapor Intrusion Study at the Former Army Materials Technology Laboratory, Watertown, MA. June.

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USEPA, 2016a. Fourth Five Year Review Report for Army Materials Testing Laboratory (AMTL) Watertown, Massachusetts concurrence letter. March 28.

USEPA, 2016b. Region 9 – Regional Screening Level (RSL) Industrial Air Supporting Table, May. https://semspub.epa.gov/work/03/2229061.pdf

USEPA, 2016c. Region 9 – Regional Screening Level (RSL) Residential Tap Water Table, May. https://semspub.epa.gov/work/03/2229087.pdf

USEPA, 2016d. USEPA National Functional Guidelines for Superfund Organic Methods Data Review. September.

Table 1 Modified QAPP Worksheet #15

Modified QAPP Worksheet #15 (UFP-QAPP Manual Section 2.8.1) – Project Action Limits and Laboratory-Specific Detection/Quantitation Limits for VOCs (AQ) Impact to Indoor Air

Analyte	CAS Number	Project Action Limit (PAL) µg/L	Lower Indoor Air RSL µg/m³	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
Methylene chloride	75-09-2	2000	260	nc	400	0.289	2
1,1-Dichloroethane	75-34-3	34	7.7	c	11.33	0.21	1
Chloroform	67-66-3	3.5	0.53	c	0.7	0.162	1
Carbon tetrachloride	56-23-5	1.8	2.0	c	0.6	0.134	1
1,2-Dichloropropane	78-87-5	10	1.2	c	2	0.133	1
Dibromochloromethane	124-48-1	0.87[1]	No IA RSL	c	0.17	0.149	1
1,1,2-Trichloroethane	79-00-5	2.6	0.088	nc	0.52	0.144	1
Tetrachloroethene	127-18-4	25	18	nc	5	0.181	1
Chlorobenzene	108-90-7	170	22	nc	34	0.178	1
Trichlorofluoromethane	75-69-4	520[1]	No IA RSL	nc	104	0.161	2
1,2-Dichloroethane	107-06-2	9.7	0.47	c	1.94	0.132	1

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3]Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal

Analyte	CAS Number	Project Action Limit µg/L	Lower Indoor Air RSL µg/m³	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
Bromomethane	74-83-9	7.3	2.2	nc	2.43	0.256	2
Bromodichloromethane	75-27-4	3.8	0.33	c	1.26	0.192	1
trans-1,3-Dichloropropene	10061-02-6	VOC not listed[2]	No IA RSL	-	-	0.164	0.5
cis-1,3-Dichloropropene	10061-01-5	VOC not listed[2]	No IA RSL	-	-	0.144	0.5
1,3-Dichloropropene, Total	542-75-6	21	3.1	c	4.2	0.144	0.5
1,1-Dichloropropene	563-58-6	VOC not listed[2]	No IA RSL	-	-	0.173	2
Bromoform	75-25-2	500	11	c	100	0.248	2
1,1,2,2-Tetrachloroethane	79-34-5	14	0.21	c	2.8	0.144	1
Benzene	71-43-2	7.1	1.6	c	1.42	0.159	0.5
Toluene	108-88-3	8100	2200	nc	1620	0.161	1
Ethylbenzene	100-41-4	15	4.9	c	3	0.168	1

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3]Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal

Analyte	CAS Number	Project Action Limit µg/L	Lower Indoor Air RSL µg/m³	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
Vinyl chloride	75-01-4	2.5	2.8	c	0.83	0.0699	1
Chloroethane (ethyl chloride)	75-00-3	9700	4400	nc	1940	0.134	2
1,1-Dichloroethene	75-35-4	82	88	nc	16.4	0.142	1
trans-1,2-Dichloroethene	156-60-5	VOC not listed[2]	No IA RSL	nc	-	0.163	1
Trichloroethene	79-01-6	2.2	0.88	nc	0.73	0.175	1
1,2-Dichlorobenzene	95-50-1	1100	88	nc	220	0.184	1
1,3-Dichlorobenzene	541-73-1	VOC not listed[2]	No IA RSL	-	-	0.186	1
1,4-Dichlorobenzene	106-46-7	11	1.1	c	2.2	0.187	1
Methyl tert-butyl ether	1634-04-4	2000	47	c	400	0.16	2
p/m-Xylene	179601-23-1	VOC not listed[2]	No IA RSL	-	-	0.332	2
o-Xylene	95-47-6	210	44	nc	42	0.33	1
Xylenes, Total	1330-20-7	160	44	nc	32	0.33	1

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3]Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal

Analyte	CAS Number	Project Action Limit µg/L	Lower Indoor Air RSL µg/m³	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
cis-1,2-Dichloroethene	156-59-2	3.6[1]	No IA RSL	nc	1.2	0.187	1
1,2-Dichloroethene, Total	540-59-0	VOC not listed[2]	No IA RSL	-	-	0.163	1
Dibromomethane	74-95-3	54	1.8	nc	10.8	0.363	2
1,2,3-Trichloropropane	96-18-4	9.3	0.13	nc	3.1	0.176	2
Styrene	100-42-5	3900	440	nc	780	0.359	1
Dichlorodifluoromethane	75-71-8	3.1	44	nc	1.03	0.245	2
Acetone	67-64-1	9,800,000	14000	nc	1.960,000	1.46	5
Carbon disulfide	75-15-0	530	310	nc	106	0.299	2
Methyl ethyl ketone	78-93-3	950000	2200	nc	190,000	1.94	5
Methyl isobutyl ketone	108-10-1	230000	1300	nc	46,000	0.416	5
2-Hexanone	591-78-6	3400	13	nc	680	0.515	5
Bromochloromethane	74-97-5	300	18	nc	60	0.138	2

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3]Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal

Analyte	CAS Number	Project Action Limit µg/L	Lower Indoor Air RSL µg/m³	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
2,2-Dichloropropane	594-20-7	VOC not listed[2]	No IA RSL	-	-	0.204	2
1,2-Dibromoethane	106-93-4	0.75	0.020	c	0.25	0.193	2
1,3-Dichloropropane	142-28-9	37[1]	No IA RSL	nc	7.4	0.212	2
1,1,1,2-Tetrachloroethane	630-20-6	17	1.7	c	3.4	0.164	1
Bromobenzene	108-86-1	260	26	nc	52	0.152	2
n-Butylbenzene	104-51-8	100[1]	No IA RSL	nc	20	0.192	2
sec-Butylbenzene	135-98-8	200[1]	No IA RSL	nc	40	0.181	2
tert-Butylbenzene	98-06-6	69[1]	No IA RSL	nc	13.8	0.185	2
o-Chlorotoluene	95-49-8	24[1]	No IA RSL	nc	4.8	0.17	2
p-Chlorotoluene	106-43-4	25[1]	No IA RSL	nc	5.0	0.185	2
1,2-Dibromo-3-chloropropane	96-12-8	0.33	.002	c	0.11	0.327	2
Hexachlorobutadiene	87-68-3	1.3	.56	c	0.43	0.217	0.6

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3]Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal

Analyte	CAS Number	Project Action Limit µg/L	Lower Indoor Air RSL µg/m^3	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
p-Isopropyltoluene	99-87-6	VOC not listed[2]	No IA RSL	-	-	0.188	2
Naphthalene	91-20-3	20	0.36	c	4	0.216	2
n-Propylbenzene	103-65-1	1000	440	nc	200	0.173	2
1,2,3-Trichlorobenzene	87-61-6	0.7	No IA RSL	nc	0.23	0.234	2
1,2,4-Trichlorobenzene	120-82-1	15	.88	nc	3	0.22	2
1,3,5-Trimethylbenzene	108-67-8	12[1]	No IA RSL	nc	2.4	0.174	2
1,2,4-Trimethylbenzene	95-63-6	12	3.1	nc	2.4	0.191	2
Diethyl ether (Ethyl Ether)	60-29-7	390[1]	No IA RSL	nc	78	0.15	2
Diisopropyl Ether	108-20-3	3000	310	nc	600	0.425	2
Ethyl-Tert-Butyl-Ether	637-92-3	VOC not listed[2]	No IA RSL	-	-	0.179	2

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3]Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal

Analyte	CAS Number	Project Action Limit µg/L	Lower Indoor Air RSL µg/m³	Health Effect	Project Quantitation Limit Goal µg/L	Laboratory – Specific	
						Detection Limits MDLs in µg/L	Quantitation Limits LOQs in µg/L
Tetrahydrofuran	109-99-9	31000	880	nc	6,200	0.525	2
Isopropylbenzene (Cumene)	98-82-8	380	180	nc	76	0.187	2
1,1,2-Trifluoro-1,2,2-trichloroethane	76-13-1	600	13000	nc	120	0.148	2
1,4-Dioxane	123-91-1	13000	2.5	c	2600	41.1	250
Tertiary-Amyl Methyl Ether [TAME]	994-05-8	VOC not listed[2]	No IA RSL	-	-	0.278	2
1,1,1-Trichloroethane	71-55-6	3100	2200	nc	620	0.158	1
Chloromethane	74-87-3	110	39	nc	22	0.176	2

[1] Residential Tap Water RSL was used when VOC was not evaluated for vapor intrusion exposure pathway.

[2] VOC not listed in Industrial Indoor Air or Residential Tap Water RSL table.

[3] Highlighted cells indicate that the laboratory-specific LOQ > the Project Quantitation Limit Goal.

Table 2 VISL Table: Calculated Groundwater Concentrations relative to Indoor Air RSLs

EPA-OLEM VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.5.1 (May 2016 RSLs)

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	0.1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator
67-64-1	Acetone	9.8E+06	1.40E+04	No IUR	**1.0E-01**			3.10E+01	A	
71-43-2	Benzene	7.1E+00	1.60E+00	**1.0E-06**	1.2E-02	7.80E-06	I	3.00E-02	I	
108-86-1	Bromobenzene	2.6E+02	2.60E+01	No IUR	9.9E-02			6.00E-02	I	
74-97-5	Bromochloromethane	3.0E+02	1.80E+01	No IUR	**1.0E-01**			4.00E-02	X	
75-27-4	Bromodichloromethane	3.8E+00	3.30E-01	1.0E-06	No RfC	3.70E-05	CA			
75-25-2	Bromoform	5.0E+02	1.10E+01	9.9E-07	No RfC	1.10E-06	I			
74-83-9	Bromomethane	7.3E+00	2.20E+00	No IUR	**1.0E-01**			5.00E-03	I	
75-15-0	Carbon Disulfide	5.3E+02	3.10E+02	No IUR	**1.0E-01**			7.00E-01	I	
56-23-5	Carbon Tetrachloride	1.8E+00	2.00E+00	9.8E-07	4.6E-03	6.00E-06	I	1.00E-01	I	
108-90-7	Chlorobenzene	1.7E+02	2.20E+01	No IUR	**1.0E-01**			5.00E-02	P	
67-66-3	Chloroform	3.5E+00	5.30E-01	9.9E-07	1.2E-03	2.30E-05	I	9.80E-02	A	
74-87-3	Chloromethane	1.1E+02	3.90E+01	No IUR	9.9E-02			9.00E-02	I	
98-82-8	Cumene	3.8E+02	1.80E+02	No IUR	**1.0E-01**			4.00E-01	I	
96-12-8	Dibromo-3-chloropropane, 1,2-	3.3E-01	2.00E-03	9.8E-07	2.3E-03	6.00E-03	P	2.00E-04	I	Mut
106-93-4	Dibromoethane, 1,2-	7.5E-01	2.00E-02	9.8E-07	5.1E-04	6.00E-04	I	9.00E-03	I	
74-95-3	Dibromomethane (Methylene Bromide)	5.4E+01	1.80E+00	No IUR	**1.0E-01**			4.00E-03	X	
95-50-1	Dichlorobenzene, 1,2-	1.1E+03	8.80E+01	No IUR	**1.0E-01**			2.00E-01	H	
106-46-7	Dichlorobenzene, 1,4-	1.1E+01	1.10E+00	9.9E-07	3.1E-04	1.10E-05	CA	8.00E-01	I	
75-71-8	Dichlorodifluoromethane	3.1E+00	4.40E+01	No IUR	**1.0E-01**			1.00E-01	X	
75-34-3	Dichloroethane, 1,1-	3.4E+01	7.70E+00	**1.0E-06**	No RfC	1.60E-06	CA			
107-06-2	Dichloroethane, 1,2-	9.7E+00	4.70E-01	1.0E-06	1.5E-02	2.60E-05	I	7.00E-03	P	
75-35-4	Dichloroethylene, 1,1-	8.2E+01	8.80E+01	No IUR	**1.0E-01**			2.00E-01	I	
78-87-5	Dichloropropane, 1,2-	1.0E+01	1.20E+00	9.8E-07	6.8E-02	1.00E-05	CA	4.00E-03	I	
542-75-6	Dichloropropene, 1,3-	2.1E+01	3.10E+00	**1.0E-06**	3.5E-02	4.00E-06	I	2.00E-02	I	
108-20-3	Diisopropyl Ether	3.0E+03	3.10E+02	No IUR	**1.0E-01**			7.00E-01	P	
123-91-1	Dioxane, 1,4-	1.3E+04	2.50E+00	**1.0E-06**	1.9E-02	5.00E-06	I	3.00E-02	I	
75-00-3	Ethyl Chloride (Chloroethane)	9.7E+03	4.40E+03	No IUR	**1.0E-01**			1.00E+01	I	
100-41-4	Ethylbenzene	1.5E+01	4.90E+00	1.0E-06	1.1E-03	2.50E-06	CA	1.00E+00	I	
87-68-3	Hexachlorobutadiene	1.3E+00	5.60E-01	**1.0E-06**	No RfC	2.20E-05	I			
591-78-6	Hexanone, 2-	3.4E+03	1.30E+01	No IUR	9.9E-02			3.00E-02	I	
78-93-3	Methyl Ethyl Ketone (2-Butanone)	9.5E+05	2.20E+03	No IUR	**1.0E-01**			5.00E+00	I	
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	2.3E+05	1.30E+03	No IUR	9.9E-02			3.00E+00	I	
1634-04-4	Methyl tert-Butyl Ether (MTBE)	2.0E+03	4.70E+01	1.0E-06	3.6E-03	2.60E-07	CA	3.00E+00	I	
75-09-2	Methylene Chloride	2.0E+03	2.60E+02	2.1E-07	9.9E-02	1.00E-08	I	6.00E-01	I	Mut
91-20-3	Naphthalene	2.0E+01	3.60E-01	1.0E-06	2.7E-02	3.40E-05	CA	3.00E-03	I	
103-65-1	Propyl benzene	1.0E+03	4.40E+02	No IUR	**1.0E-01**			1.00E+00	X	
100-42-5	Styrene	3.9E+03	4.40E+02	No IUR	**1.0E-01**			1.00E+00	I	
630-20-6	Tetrachloroethane, 1,1,1,2-	1.7E+01	1.70E+00	**1.0E-06**	No RfC	7.40E-06	I			
79-34-5	Tetrachloroethane, 1,1,2,2-	1.4E+01	2.10E-01	9.9E-07	No RfC	5.80E-05	CA			
127-18-4	Tetrachloroethylene	2.5E+01	1.80E+01	3.8E-07	**1.0E-01**	2.60E-07	I	4.00E-02	I	
109-99-9	Tetrahydrofuran	3.1E+05	8.80E+02	No IUR	**1.0E-01**			2.00E+00	I	
108-88-3	Toluene	8.1E+03	2.20E+03	No IUR	**1.0E-01**			5.00E+00	I	
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	6.0E+02	1.30E+04	No IUR	9.9E-02			3.00E+01	H	
120-82-1	Trichlorobenzene, 1,2,4-	1.5E+01	8.80E-01	No IUR	**1.0E-01**			2.00E-03	P	
71-55-6	Trichloroethane, 1,1,1-	3.1E+03	2.20E+03	No IUR	**1.0E-01**			5.00E+00	I	
79-00-5	Trichloroethane, 1,1,2-	2.6E+00	8.80E-02	1.1E-07	**1.0E-01**	1.60E-05	I	2.00E-04	X	
79-01-6	Trichloroethylene	2.2E+00	8.80E-01	2.9E-07	**1.0E-01**	see note	I	2.00E-03	I	TCE
96-18-4	Trichloropropane, 1,2,3-	9.3E+00	1.30E-01	No IUR	9.9E-02			3.00E-04	I	Mut
95-63-6	Trimethylbenzene, 1,2,4-	1.2E+01	3.10E+00	No IUR	**1.0E-01**			7.00E-03	P	
75-01-4	Vinyl Chloride	2.5E+00	2.80E+00	**1.0E-06**	6.4E-03	4.40E-06	I	1.00E-01	I	VC
95-47-6	Xylene, o-	2.1E+02	4.40E+01	No IUR	**1.0E-01**			1.00E-01	S	
1330-20-7	Xylenes	1.6E+02	4.40E+01	No IUR	**1.0E-01**			1.00E-01	I	

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	25
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	25
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	250
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors		Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

Trichloroethylene	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
	mIURTCE_R_GW	1.00E-06	mIURTCE_C_GW	0.00E+00	mIURTCE_GW	0.00E+00
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	4.10E-06

Mutagenic Chemicals — The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 — This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride — See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:
I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user.
Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.
Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

Table 3 DOD QSM LCS LIMITS for 8260

Table 24. Method 8260 Water Matrix

CAS ID	Analyte	N Records	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
630-20-6	1,1,1,2-Tetrachloroethane	24511	101.1	7.6	78	124
71-55-6	1,1,1-Trichloroethane	28223	102.7	9.6	74	131
79-34-5	1,1,2,2-Tetrachloroethane	27450	96.4	8.3	71	121
79-00-5	1,1,2-Trichloroethane	27338	99.5	6.5	80	119
76-13-1	1,1,2-Trifluoro-1,2,2-trichloroethane [Freon-113]	21122	103	11.1	70	136
75-34-3	1,1-Dichloroethane	28154	101.3	8	77	125
75-35-4	1,1-Dichloroethene	29436	101	10	71	131
563-58-6	1,1-Dichloropropene	23631	102	7.8	79	125
87-61-6	1,2,3-Trichlorobenzene	24271	98.7	10.1	69	129
96-18-4	1,2,3-Trichloropropane	24525	97.5	8	73	122
526-73-8	1,2,3-Trimethylbenzene	2965	100.9	6.2	82	120
120-82-1	1,2,4-Trichlorobenzene	25290	99.8	10.1	69	130
95-63-6	1,2,4-Trimethylbenzene	27917	99.6	8	76	124
96-12-8	1,2-Dibromo-3-chloropropane	24955	94.9	11.1	62	128
106-93-4	1,2-Dibromoethane	29096	99	7.2	77	121
95-50-1	1,2-Dichlorobenzene	27583	99.4	6.5	80	119
107-06-2	1,2-Dichloroethane	32965	100.3	9.2	73	128
17060-07-0	1,2-Dichloroethane-d4	8673	99.5	6.1	81	118
540-59-0	1,2-Dichloroethene	18667	100.2	7.1	79	121
78-87-5	1,2-Dichloropropane	27787	100.1	7.2	78	122
354-23-4	1,2-Dichlorotrifluoroethane [Freon 123a]	3144	103.1	10.9	70	136

108-70-3	1,3,5-Trichlorobenzene	10037	102.1	9.2	75	130
108-67-8	1,3,5-Trimethylbenzene	27820	99.5	8.1	75	124

Table 24. Method 8260 Water Matrix

CAS ID	Analyte	N Records	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
106-99-0	1,3-Butadiene	1202	100.6	19.2	43	158
541-73-1	1,3-Dichlorobenzene	26951	99.7	6.5	80	119
142-28-9	1,3-Dichloropropane	23811	99.1	6.5	80	119
542-75-6	1,3-Dichloropropene	9784	99.9	7.6	77	123
106-46-7	1,4-Dichlorobenzene	27715	98.3	6.5	79	118
105-05-5	1,4-Diethylbenzene	1980	98.4	6.4	79	118
123-91-1	1,4-Dioxane	17866	99	13.4	59	139
544-10-5	1-Chlorohexane	5790	99.6	8	76	124
540-84-1	2,2,4-Trimethylpentane [Isooctane]	5432	95.2	12.3	58	132
594-20-7	2,2-Dichloropropane	23775	99.7	13.2	60	139
75-85-4	2-Butanol	4332	92.7	9.1	66	120
78-93-3	2-Butanone [MEK]	26659	99.6	14.6	56	143
126-99-8	2-Chloro-1,3-butadiene	15673	100	11.7	65	135
110-75-8	2-Chloroethyl vinyl ether	18225	94.7	14.7	51	139
95-49-8	2-Chlorotoluene	23750	100	7.2	79	122
591-78-6	2-Hexanone	25368	97.9	13.5	57	139
91-57-6	2-Methylnaphthalene	3754	79.4	20.9	17	142
79-46-9	2-Nitropropane	10213	92.6	14.5	49	136
67-63-0	2-Propanol [Isopropyl alcohol]	2034	98.8	14.4	56	142
624-95-3	3,3-Dimethyl-1-butanol	6491	90.9	13.9	49	133

460-00-4	4-Bromofluorobenzene	9971	99.7	4.9	85	114
106-43-4	4-Chlorotoluene	23616	99.9	7.4	78	122
108-10-1	4-Methyl-2-pentanone [MIBK]	25796	98.5	10.6	67	130
67-64-1	Acetone	25006	99.5	20.1	39	160
75-05-8	Acetonitrile	13308	95.8	15.2	50	142

Table 24. Method 8260 Water Matrix

CAS ID	Analyte	N Records	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
107-02-8	Acrolein [Propenal]	16380	96.8	19.3	39	155
107-13-1	Acrylonitrile	20173	99	11.9	63	135
107-05-1	Allyl chloride	15758	99	10.4	68	130
71-43-2	Benzene	34376	99.4	6.9	79	120
100-44-7	Benzyl chloride	10675	90.1	15.9	42	138
108-86-1	Bromobenzene	23762	99.7	6.7	80	120
74-97-5	Bromochloromethane	24356	100.8	7.5	78	123
75-27-4	Bromodichloromethane	26888	101.8	7.8	79	125
75-25-2	Bromoform	27675	97.8	10.8	66	130
74-83-9	Bromomethane	26717	97	14.7	53	141
75-15-0	Carbon disulfide	25719	98.8	11.5	64	133
56-23-5	Carbon tetrachloride	28870	103.8	10.7	72	136
108-90-7	Chlorobenzene	29802	100	6.1	82	118
124-48-1	Chlorodibromomethane	27424	100	8.5	74	126
75-45-6	Chlorodifluoromethane	7197	84.4	14.9	40	129
75-00-3	Chloroethane	27069	99	13	60	138
67-66-3	Chloroform	29373	101.1	7.5	79	124

74-87-3	Chloromethane	27697	94.5	15	50	139
156-59-2	cis-1,2-Dichloroethene	27935	100.1	7.5	78	123
10061-01-5	cis-1,3-Dichloropropene	27197	99.5	8	75	124
1476-11-5	cis-1,4-Dichloro-2-butene	1524	101.5	14.9	57	146
110-82-7	Cyclohexane	20438	100.4	10	71	130
1868-53-7	Dibromofluoromethane	5702	99.1	6.5	80	119
74-95-3	Dibromomethane	24473	101.1	7.3	79	123
75-71-8	Dichlorodifluoromethane [Freon-12]	25410	92	20.1	32	152

Table 24. Method 8260 Water Matrix

CAS ID	Analyte	N Records	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
75-43-4	Dichlorofluoromethane	1504	101.5	9.8	72	131
60-29-7	Diethyl ether	17189	98.6	10.2	68	129
108-20-3	Diisopropyl ether	22989	97.5	10.3	67	128
64-17-5	Ethanol	9543	99.2	17.1	48	151
141-78-6	Ethyl acetate	9208	96.8	13.9	55	138
97-63-2	Ethyl methacrylate	16674	98.7	9	72	126
637-92-3	Ethyl tert-butyl ether	19841	98.3	9.4	70	127
100-41-4	Ethylbenzene	33325	99.8	7	79	121
462-06-6	Fluorobenzene	1373	97.9	6.1	80	116
142-82-5	Heptane	11878	94.4	15	49	140
87-68-3	Hexachlorobutadiene	23535	100.1	11.3	66	134
67-72-1	Hexachloroethane	8718	102.9	10.3	72	134
110-54-3	Hexane	15545	95.5	15.9	48	143
74-88-4	Iodomethane	20229	100	10.4	69	131

78-83-1	Isobutyl alcohol	14123	97.7	11.7	63	133
108-21-4	Isopropyl acetate [Acetic acid]	7216	97.8	11.6	63	133
98-82-8	Isopropylbenzene	28636	101.5	9.9	72	131
179601-23-1	m/p-Xylene [3/4-Xylene]	28168	100.5	6.9	80	121
126-98-7	Methacrylonitrile	15982	97.9	11.6	63	133
79-20-9	Methyl acetate	19698	96	13.2	56	136
80-62-6	Methyl methacrylate	16524	97.7	10.2	67	128
1634-04-4	Methyl tert-butyl ether [MTBE]	29660	97.3	8.8	71	124
108-87-2	Methylcyclohexane	20025	101.8	10.1	72	132
75-09-2	Methylene chloride	27659	99.4	8.3	74	124
123-86-4	n-Butyl acetate	7247	96.8	9.4	69	125

Table 24. Method 8260 Water Matrix

CAS ID	Analyte	N Records	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
71-36-3	n-Butyl alcohol	10122	95.1	12	59	131
104-51-8	n-Butylbenzene	24088	101.1	8.8	75	128
109-60-4	n-Propyl acetate	602	100.8	8.3	76	126
103-65-1	n-Propylbenzene	24419	101	8.5	76	126
91-20-3	Naphthalene	27847	94.6	11.3	61	128
95-47-6	o-Xylene	31776	100	7.2	78	122
99-87-6	p-Isopropyltoluene [p-Cymene]	24335	102	8.5	77	127
76-01-7	Pentachloroethane	11688	101.1	10.7	69	133
109-66-0	Pentane	3915	74.8	19.7	16	134
107-12-0	Propionitrile [Ethyl cyanide]	15701	99.9	12	64	136
135-98-8	sec-Butylbenzene	24191	101.1	8.1	77	126

100-42-5	Styrene	26985	100.5	7.6	78	123
994-05-8	tert-Amyl methyl ether [TAME]	19726	98.1	10.1	68	128
75-65-0	tert-Butyl alcohol	21112	98.6	10.1	68	129
762-75-4	tert-Butyl formate	6651	98.1	11.1	65	132
98-06-6	tert-Butylbenzene	23919	101	7.7	78	124
127-18-4	Tetrachloroethene	29017	101.3	9.3	74	129
109-99-9	Tetrahydrofuran	18021	95	12.8	57	133
108-88-3	Toluene	33510	100.1	6.8	80	121
2037-26-5	Toluene-d8	9809	100.4	3.8	89	112
156-60-5	trans-1,2-Dichloroethene	27663	99.5	8.2	75	124
10061-02-6	trans-1,3-Dichloropropene	27134	100	8.9	73	127
110-57-6	trans-1,4-Dichloro-2-butene	19320	91.5	16.1	43	140
79-01-6	Trichloroethene	30150	101.1	7.3	79	123
75-69-4	Trichlorofluoromethane	26108	103	12.8	65	141

Table 24. Method 8260 Water Matrix

CAS ID	Analyte	N Records	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
	[Freon-11]					
108-05-4	Vinyl acetate	18941	100.2	15.3	54	146
75-01-4	Vinyl chloride	29472	97.4	13.2	58	137
1330-20-7	Xylenes [total]	23426	100.1	7	79	121